ENHANCED RECOVERY AFTER SPINE SURGERY: STATE OF THE ART IN THE RUSSIAN FEDERATION

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Objective. To analyze the attitude of neurosurgeons to the technology of enhanced recovery after spine and spinal cord surgery in the Russian Federation.

Material and Methods. In March 2022, a continuous cohort comparative sociological study was conducted among 83 neurosurgeons of the Russian Federation, during which they were asked to fill out a specially designed online questionnaire consisting of 22 questions on the Google Forms platform.

Results. The vast majority of respondents (95.2 %) noted the lack of information in the Russian literature on the technology of enhanced recovery after surgery (ERAS). Nevertheless, most neurosurgeons, regardless of specialization, are familiar with the terms "fast track" (79.5 %) and "ERAS" (60.2 %). Only 44.6 % of specialists declared the implementation of ERAS recommendations into their daily clinical practice, while 78.3 % of neurosurgeons draw attention to the existence of problems that hamper adoption of enhanced recovery protocols (ERP) in Russia. The interviewed respondents are confident that it is possible to introduce ERP into spinal neurosurgery in adults (91.6 %) and children (85.5 %) in Russia. Every second respondent (50.6 %) considers it possible to directly extrapolate foreign ERP into clinical practice in Russian healthcare. Spinal neurosurgeons are more aware of ERAS than cerebral neurosurgeons ($p = 0.017$), and they also more often use elements of ERAS in their clinical practice ($p = 0.002$). In other parameters, the respondents did not differ significantly depending on their specialization. Only 7.2 % of interviewed neurosurgeons work in private clinics. All of them are engaged in spinal surgery and introduce the ERAS technology into their clinical practice. Less than half (40.0 %) of neurosurgeons in public clinics implement elements of the ERAS ($p = 0.007$). More than half (69.7 %) of specialists and every second manager consider the introduction of ERAS in a neurosurgical clinic to be progressive, and only a few of them (3.6 %), on the contrary, believe that the quality of medical care may decrease with the introduction of ERAS. Neurosurgeons ($n = 13$) identified 7 clinics of the Russian Federation, where the enhanced recovery protocol after spine surgery is implemented. In total, according to the results of the study, 23 elements of the ERAS protocol are implemented in the practice of respondents ($n = 20$) in the conditions of Russian healthcare.

Conclusions. Despite the lack of publications in the Russian literature and the existing organizational problems in the context of domestic healthcare, neurosurgeons have a positive attitude towards the introduction of ERAS protocol into clinical practice. This protocol or its individual elements are already successfully implemented in a group of clinics in Russia.

Key Words: enhanced recovery after surgery, survey, vertebrology, pediatric neurosurgery, spine surgery, Russia.

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The technology of enhanced recovery after surgery, better known globally as fast track or Enhanced Recovery after surgery (ERAS), is an advanced idea of perioperative management of patients in various surgical branches. The Danish professor Kehlet et al. [1] was the first to publish the outcomes of its introduction into clinical practice in 1997. Nowadays, the abbreviation ERAS is generally accepted in English-language literature, and in Russian literature, the enhanced recovery or restoration program (ERP) is more often mentioned [2, 3].

By definition, ERAS are guidelines for the perioperative management of surgical patients under evidence-based medicine (https://erassociety.org/guidelines). These guidelines were created and implemented in clinical practice all over the world by the ERAS® Society (https://erassociety.org), established in 2010 [3]. Since then, over 9,000 papers on ERAS in various areas of surgery have been published in 18 languages, with over 33 thousand authors from 91 countries participating [4].

Despite the considerable amount of evidence supporting the effectiveness of enhanced recovery after surgery in many branches, a little over 100 studies on ERAS in spine surgery have been published since 2014, according to the PubMed database [3], and the first ERAS® Society guidelines for spine surgery appeared in 2021 [5]. According to the eLibrary database, only a few articles on enhanced recovery after spine surgery have been published in the Russian literature to date [3, 6–10]. In this regard, the objective is to analyze the attitude of neurosurgeons towards the technology of enhanced recovery after spine

and spinal cord surgery in the Russian Federation.

The design of the study is cohort and comparative. The level of study evidence is 3b.

Material and Methods

A continuous cohort comparative sociological study was performed in March 2022 among 83 Russian neurosurgeons and vertebrologists. The questionnaire developed by the team of authors is based on the questionnaire used in a similar European study [11]. It was posted freely on the Google Forms platform. The study questionnaire was distributed through specialized neurosurgical groups in messengers as well as privately through representatives of various Russian neurosurgical hospitals. The majority of the questions were closed-ended with one answer option, as well as open-ended (n = 2) and with the option to select several answers (n = 3). Totally, the questionnaire included 22 questions in two blocks: demographic and professional data on respondents, as well as an evaluation of the status and prospects for the development of ERAS in Russia.

The data was analyzed using the IBM SPSS Statistics 23 statistical software. The results are given as a proportion (%). Pearson's chi-squared test was used for comparative data analysis. The differences were considered statistically significant at $p < 0.05$. Cramer's V was used to estimate the strength of the association. The interpretation of the results was done according to the guidelines of Rea & Parker [12].

Results

Demographic and professional characteristics of respondents

Participants in the sociological survey (Table 1) were mostly men (86.7 %) aged 30 to 40 years (42.2 %). 88.0 % of respondents work as neurosurgeons, mainly in public hospitals (92.8 %), with work experience in the specialty up to 20 years (85.5 %). The majority of surgeons are members of one or another occupational association (78.3 %). The interviewed specialists represent all federal districts of the Russian Federation and work mainly in the Central (36.1 %) and Volga (32.5 %) federal districts. 12 % of them are executives. 65.1 % consider themselves practicing spine surgeons, and 32.5 % of respondents are involved in the surgical treatment of children suffering from spinal pathology.

State of the art of ERAS technology in Russia

The overall majority of respondents (95.2 %) point out the lack of data in the Russian literature on enhanced recovery after surgery. Nonetheless, the majority of neurosurgeons, regardless of specialization, are familiar with the terms "fast track" (79.5 %) and "ERAS" (60.2 %).

A total of 44.6 % of specialists stated that they implemented ERAS guidelines in their daily clinical practice (Fig. 1). Meanwhile, 78.3 % of neurosurgeons point to the presence of challenges to the implementation of enhanced recovery protocols (ERP) in Russia. However, the respondents are confident that it is feasible to introduce ERP into spine neurosurgery for adults (91.6 %) and children (85.5 %) in Russia. Every second respondent (50.6 %) believes it possible to directly extrapolate foreign guidelines for enhanced recovery into clinical practice within the scope of Russian healthcare.

Spine neurosurgeons are more aware of ERP compared to cerebral ones ($p = 0.017$) and also more often apply elements of enhanced recovery technology in their clinical practice ($p = 0.002$). In terms of other parameters, the respondents did not differ significantly depending on their specialization (Table 2).

Only 7.2 % of neurosurgeons work in private hospitals. They are involved in spine surgery and implement the technology under consideration into their clinical practice. Speaking of neurosurgeons in public hospitals, less than half (40.0 %) implement ERP elements ($p = 0.007$).

More than half (69.7 %) of specialists and every second medical officer consider the introduction of technology in a neurosurgical clinic to be progressive, and only a few of them (3.6 %) believe that the quality of medical care may decrease with the implementation of ERAS (Fig. 2).

Elements of the ERAS protocol

Totally, according to the results of the conducted study, 23 elements of the ERAS protocol are being implemented in the practice of respondents (n = 20) in the conditions of domestic healthcare (Fig. 3). Neurosurgeons (n = 13) pointed out 7 hospitals in Russia, where enhanced recovery after surgery is being implemented:

- The Central Clinical Hospital of the Administrative directorate of the President of the Russian Federation (Moscow);
- N.N. Burdenko National Medical Research Center of Neurosurgery (Moscow);
- N.N. Priorov National Medical Research Center of Traumatology and Orthopedics (Moscow);
- V.A. Almazov National Medical Research Center (Saint Petersburg);
- I.P. Pavlov First Saint Petersburg State Medical University (Saint Petersburg);
- Privolzhsky Research Medical University (Nizhniy Novgorod);
- Clinical Hospital "Russian Railways-Medicine" (Irkutsk).

Discussion

As far as we know, this is the first study in the Russian Federation, the second in Europe [11], and the third in the worldwide English-language literature [13] to investigate neuro and spine surgeons' opinions and knowledge of the technology of enhanced recovery after surgery (ERAS) in neurosurgery in general and surgery of the spine and spinal cord in particular (Table 3).

The results of the study demonstrate that Russian neurosurgeons are well aware of the technology of enhanced recovery after surgery. Almost every second specialist already implements elements of this technology in their practice. Our data are fully compatible with the results of our European [11] and American colleagues [13]. Despite the lack of data on ERAS technology in the Russian literature, according to the majority of

respondents, surgeons (63.9 %), regardless of their area of expertise, and their officers (50.0 %) are confident that the technology advances patient surgical care and raises the standard of healthcare. The obtained information corresponds to that obtained in the European study (63.7 % and 62.0 %, respectively) [11]. Nevertheless, it is worth drawing attention to the fact that domestic health care managers, apparently, are less aware of the advantages of introducing this technology into clinical practice.

ERAS and Cerebral Neurosurgery

Till recently, it was considered that ERAS guidelines were implemented in practice only in spinal neurosurgery [11, 14–16]. Moreover, it is somewhat more common in the USA (62.2 %) [13], compared with European countries (47.5 %) [11]. In cerebral neurosurgery, the practical implementation of ERP is considerably lower (17.3 % [13] – 18.3 % [11]). However, a detailed review of the world literature for recent years has revealed a considerable rise in articles on cerebral surgery. The surgical management of hemifacial spasm [17], tumors of the chiasmal cell region [18, 19], cerebral aneurysms [20, 21], gliomas [22, 23], tumors of supra- and subtentorial localization [14, 24, 25], as well as general planned craniotomies [15, 26, 27] are all described in these papers as having been done in accordance with ERAS guidelines. Nowadays, a number of review articles on the use of enhanced recovery after surgery technology in cerebral surgery have been published in the English-language literature [16, 28–30], and in 2022, several systematic reviews on this issue were published [31–33]. 13 original articles on cerebral neurosurgery and 22 original articles on spine neurosurgery were found in a systematic review by Fiani et al. [34] that was published in 2022. As for Russian neurosurgery, according to the eLibrary database, we managed to find the only paper describing the anesthetic aspects of enhanced recovery after surgery in cerebral neurosurgery [35].

ERAS and spinal neurosurgery

According to our research's findings, more than a half of respondents (65.1 %) at the age of 30 to 50 consider themselves to be practicing spine surgeons. Our data confirm the findings of the European study, which showed that spine neurosurgeons, compared

Table 1

Demographic and professional features of respondents

Parameters	Respondents, n (%)
Age	
Under 30 years old	29 (34.9)
30–40 years old	35 (42.2)
40–50 years old	14 (16.9)
Over 50 years old	5 (6.0)
Gender	
Male	72 (86.7)
Female	11 (13.3)
Specialty	
Neurosurgeon	72 (86.7)
Traumatologist	10 (12.0)
Traumatologist and neurosurgeon	1 (1.3)
Work experience in the specialty	
Under 5 years	32 (38.6)
5–10 years	19 (22.8)
10–20 years	20 (24.1)
Over 20 years	12 (14.5)
Are you a member of a professional association?	
Association of neurosurgeons of Russia/ WSSFN/ EANS/ AANS	44 (53.0)
Association of spine surgeons of Russia / AO SPINE	29 (34.9)
Association of pediatric neurosurgeons of Russia/ISPN	2 (2.4)
Association of traumatologists of Russia (ATOR)/SICOT	2 (2.4)
Other (SRS/ POX/ РАДХ/ RAYNS/ ESSFN)	4 (4.8
No membership in professional associations	18 (21.7)
In which district of the Russian Federation do you work?	
Central federal district	30 (36.1)
Northwestern federal district	13 (15.7)
Southern federal district	2 (2.4)
North Caucasian federal district	2 (2.4)
Volga federal district	27 (32.5)
Ural federal district	1 (1.2)
Siberian federal district	6 (7.3)
Far Eastern federal district	2 (2.4)
Your current position	
Resident	7 (8.4)
Certified specialist	66 (79.6)
Head of a clinic/unit	10 (12.0)
Main sphere of practice	
Public institution	77 (92.8)
Private clinic	6 (7.2)
Are you a practicing spinal surgeon?	
Yes	54 (65.1)
No	29 (34.9)
Do you operate on children with spinal pathology?	
Yes	27 (32.5)
No	56 (67.5)

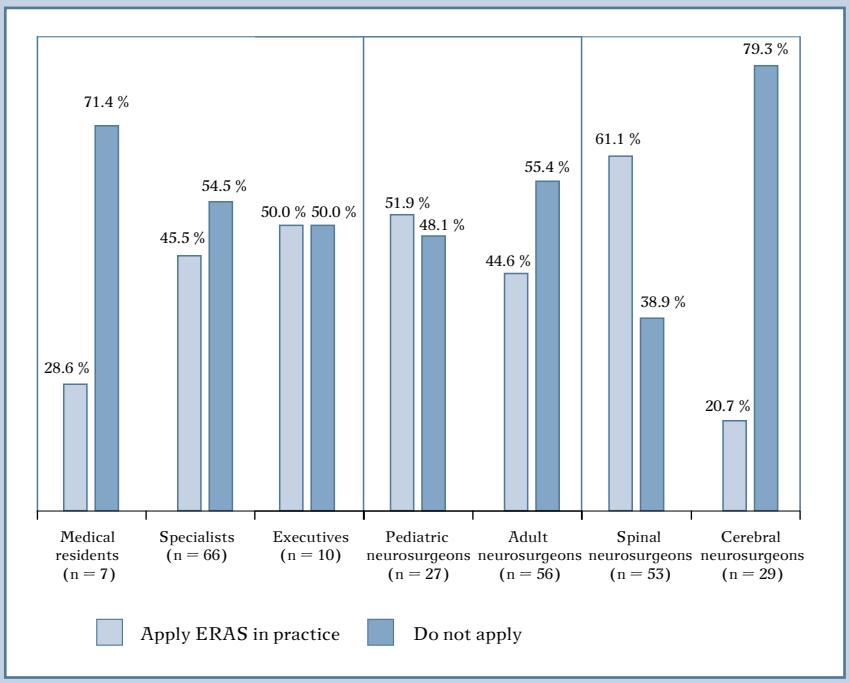

Fig. 1
Practical implementation of ERAS technology in clinical practice: the opinion of neurosurgeons of various groups and specializations

with cerebral ones, are more informed regarding the technology of enhanced recovery after surgery and are considerably more likely to fulfil the elements of these guidelines in their clinical practice (47.5 % vs 18.3 %; $p < 0.001$) [11].

Generally, only half of Russian (57.4 %) and European (47.5 %) spine surgeons put into practice the elements of enhanced recovery after surgery. This can be explained by the fact that the technology was just recently implemented [1]. It caused the first articles on ERAS in spine surgery to appear in 2014 [3, 8, 36] and the first ERAS guidelines for spine surgery to be approved by the ERAS® Society only in 2021 [5]. All of this is connected to several organizational difficulties with the use of technology in clinical practice.

Russian specialists are convinced that it is feasible to introduce ERAS in Russia into spinal neurosurgery in adults (91.6 %) and children (85.5 %). As a result, in light of the findings presented, it is crucial to validate the international guidelines and create clinical recommendations for the implementation of ERP in neurosurgery concerning the best techniques used by Russian abdominal surgeons [37].

As mentioned above, according to the survey of respondents, 7 hospitals in Russia are already implementing the technology of enhanced recovery after surgery in spine surgery. As far as we know, in most cases, this is due to the procurement system in the hospital that regulates the elements of perioperative management of patients (preventive antibiotics, admission to the hospital, algorithms for pain relief, etc.). According to the model adopted in Western clinics, ERAS technology is being implemented at the Clinical Hospital «Russian Railways-Medicine» (Irkutsk), where the developed guideline (program) of enhanced recovery has been approved and completely implemented in clinical practice [7].

ERAS and pediatric neurosurgery

At the time of writing this paper, we manager to find only a small number of articles on the use of enhanced recovery technology in pediatric neurosurgery. Existing works are dedicated to the use of ERAS in spinal surgery [8, 38], namely in surgery of scoliotic deformities of spine [36, 39–48] and selective dorsal rhizotomy [49]. Published studies on enhanced recovery technology demonstrate the effectiveness and safety of its implementation in clinical practice in children. It decreases the number of complications and health care costs and helps to enhance the satisfaction of patients and their parents with the treatment outcomes. [3, 5, 8, 38, 50–53].

We failed to find papers analyzing the professional opinion of pediatric neurosurgeons on ERAS in the world or domestic literature. The only paper published in 2018 by Short et al. [54] describes a professional survey among 257 pediatric surgeons. 68.4 % of them are familiar with the enhanced recovery after surgery technology, but only 19.2 % of respondents put it into practice. The vast majority of pediatric surgeons have either implemented or are about to implement 14 of the 21 suggested ERAS protocol elements (67 %). At the time of the survey, just over 10 % of surgeons were unsure or unwilling to implement the remaining 7 elements into their surgical practice (restriction of mechanical preparation of the intestine; minimization of preoperative fasting and the use of nasogastric probes; thromboembolism prevention; the use of a standard anesthesia guideline, including conduction anesthesia; normovolemia; and the use of insulin to control severe hyperglycemia in the intensive care unit).

Among the respondents to our study, 85.5 % of surgeons believe it is feasible to implement the technology of enhanced recovery after surgery in children in Russia. Meanwhile, 32.5 % of neurosurgeons aged 30 to 50 years (74.0 %) are involved in the surgical treatment of children with spinal pathology. The vast majority of pediatric neurosurgeons are acquainted with the terms “fast track” (92.6 %) and “ERAS” (66.7 %). According to the

Table 2
Results of a survey of spinal neurosurgeons in the general cohort

Parameter	Spinal neurosurgeons (n = 54)	Cerebral neurosurgeons (n = 29)	p	Cramer's V/strength of association
Gender				
Male	51 (94.4 %)	21 (72.4 %)	0.013	0.274/moderate
Female	3 (5.6 %)	8 (27.6 %)		
Are you familiar with the fast track concept?				
Yes	44 (81.5 %)	22 (75.9 %)	0.545	0.066/weak
No	10 (18.5 %)	7 (14.1 %)		
Place of work				
Private clinic	6 (11.1 %)	0 (0.0 %)	0.062	0.205/moderate
Public clinic	48 (88.9 %)	29 (100.0 %)		
Are you familiar with the ERAS concept?				
Yes	38 (70.4 %)	12 (41.4 %)	0.017	0.263/moderate
No	16 (29.6 %)	17 (58.6 %)		
Are the terms fast track and ERAS synonymous?				
Yes	30 (55.6 %)	11 (37.9 %)	0.170	0.151/weak
No	24 (44.4 %)	18 (62.1 %)		
Application of enhanced recovery technology in practice				
Yes	31 (57.4 %)	6 (20.7 %)	0.002	0.335/moderate
No	23 (42.6 %)	23 (79.3 %)		
Is it possible to directly extrapolate foreign protocols into the clinical practice of domestic healthcare?				
Yes	26 (48.1 %)	15 (51.7 %)	0.756	0.034/none
No	28 (51.9 %)	14 (48.3 %)		
Are there any problems that hinder the implementation of ERAS protocols in Russia?				
Yes	41 (75.9 %)	24 (82.8 %)	0.471	0.079/none
No	13 (24.1 %)	5 (17.2 %)		
Opinion on ERAS technology				
Progress	34 (62.9 %)	18 (62.1 %)	0.870	0.123/weak
Decrease in quality	2 (3.7 %)	0 (0.0 %)		
Minor tactics changes	6 (11.1 %)	4 (13.9 %)		
Significant tactics changes	3 (5.6 %)	2 (6.9 %)		
Difficult to answer	9 (16.7 %)	5 (17.2 %)		

majority of pediatric specialists (77.8 %), the implementation of ERAS will cause improvement of treatment outcomes or considerable changes in treatment strategy, and in practice, already more than a half of pediatric neurosurgeons (55.6 %; p = 0.005) fulfil the elements of ERP (Fig. 1). According to the results of our study, there is a higher understanding and practical implementation of ERAS protocols compared to the data obtained in 2018 by Short et al. [54]. This could be attributed to the advancement of current research as well as the dynamic implementation of protocols for enhanced recovery after surgery in clinical practice in recent years.

Challenges and perspectives of ERAS development in Russia

The majority of neurosurgeons (78.3 %) consider that there are hard problems in implementing ERP in Russia. During the survey, respondents (n = 30) gave specific suggestions and identified challenges limiting the development of ERAS in our country. They can be subdivided into legal (development of clinical recommendations) and organizational. The latter include technical support and the purchase of surgical hardware; administrative support; reorganization of outpatient care; succession at the stages of medical care; preoperative preparation of patients; training of specialists in ERAS technology, perioperative rehabilitation. American neurosurgeons [13], in turn, reported hardships with adaptation to the protocols of the medical staff of multidisciplinary institutions, integration of electronic medical records, multidisciplinary disagreements, and practical realization of protocols by different specialists. In their study, 69.5 % of surgeons stated that the creation and practical application of ERAS protocols were accomplished through the collaborative efforts of multiple units, including neurosurgery and the anesthetic unit.

In our study, less than 10 % of neurosurgeons are employed in private medicine. However, all of them implement

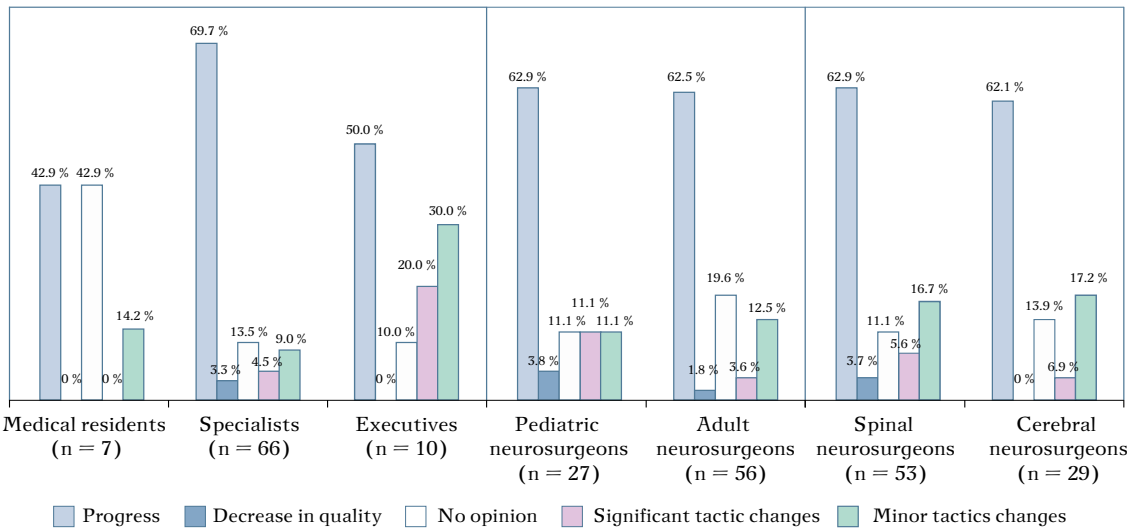

Fig. 2
Attitude towards the implementation of ERAS technology into clinical practice: the opinion of neurosurgeons of various groups and specializations

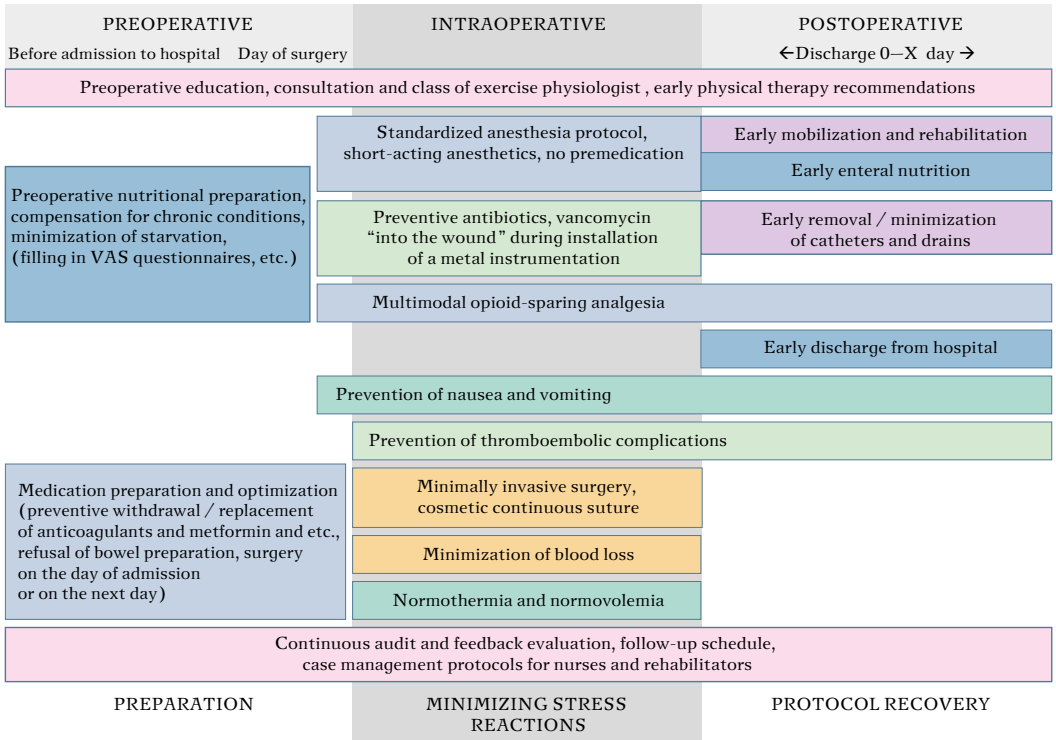

Fig. 3
Consolidated protocol of applied elements of enhanced recovery after surgery in neurosurgical clinics of Russia

Table 3
Comparative chart of research results of the professional community of neurosurgeons on ERAS technology in different countries

Parameters	Authors of the present article	Corniola et al. [12]	Agarwal et al. [14]
Year of study	2022	2019–2020	2021
Country	Russia	Europe countries	USA
Number of respondents	83	234	39
Representatives of private medicine	7.2 %	22.6 %	No data
Number of questions in the questionnaire	22	9	15
Familiar with ERAS technology	79.5 %	45.3 %	No data
Practical implementation of ERAS: in general; cerebral/spinal surgeons	44.6 %; 20.7 %/57.4 % ($p = 0.002$)	35.9 %; 18.3 %/47.5 % ($p < 0.0001$)	58.9 %; no data
Practical implementation of ERAS: private/public medicine	100.0 %/40.0 %	45.3 %/33.1 %	No data
Satisfaction of medical staff with the implementation of ERAS	No data	No data	4.00 ± 0.81 ($n = 22$) on a 5-point Likert scale
Number of specialists/executives who consider ERAS to be an advance in the surgical treatment of patients	63.7 %/50.0 %	63.9 %/62.0 %	No data

ERAS in practice. Among neurosurgeons in public hospitals, statistically significantly less than a half (40 %) implement the ERP elements. This is due to the liquidity of technology in neurosurgery [13, 19, 34, 36, 39, 40, 49, 55–58] and in other surgical industries that makes it highly demanded for private medicine. In turn, Corniola et al. [11] did not discover any distinctions in relation to ERAS and the implementation of the program in private and public medicine in Europe. It may be associated with different models of healthcare financing in Russia and European countries. Additionally, the funding model and the demands of the inspection structures may limit the implementation of ERAS. An earlier discharge may be connected with a lower payment for a case of treatment, resulting in lower incomes for the hospital and also increasing the burden on the outpatient unit, which is not always cost-efficient for hospitals in the current situation. This provision requires revision and discussion by healthcare managers, since ERAS has repeatedly demonstrated its economic efficiency

Studies on satisfaction with the implementation of enhanced recovery technology in neurosurgery have shown high rates of approval of ERAS by medical staff [13, 58], patients and their parents [6, 13, 21, 32–34, 41, 57–60]. Thus, the mean satisfaction of medical staff with the introduction of ERAS was 4.00 ± 0.81 points on the 5-point Likert scale [13]. In endoscopic pituitary surgery in the ERAS group, patient satisfaction on the Likert scale was 9.7/10.0 points [18], in aneurysm surgery – 95.0 % vs 76.9 % ($p = 0.003$) [21], and overall, there is a high level of satisfaction with planned craniotomies [60]. According to Liu et al. [60], the age of the patient, prevention of nausea and vomiting, the application of an absorbable subcuticular suture and a shorter hospital stay were separate predictors of overall patient satisfaction. The authors remark that careful follow-up after discharge can boost patients' sense of safety. Patients value the sequential transmission of data as well as professional support when participating in the ERAS program. It is important to reward the active participation of patients in treatment and teach them to take responsibility for their own enhanced recovery [60].

Limitations and perspectives of the study

The study conducted has several limitations:

- low representativeness of the sample by the number of respondents (less than 5 % of Russian neurosurgeons);
- technical, time and social restrictions on the free distribution of the questionnaire, which cause the predominance of experts from the Central and Volga Federal Districts.

Despite these limitations, studies provide significant primary information on the state of enhanced recovery technology in spinal neurosurgery in the Russian Federation.

We expect that the proven effectiveness and safety of ERP, its cost-efficiency, the high satisfaction of patients and medical staff, as well as the positive experience of its implementation in the conditions of Russian healthcare in abdominal surgery, will promote further highly evidence-based studies. We also hope that it will support healthcare managers in making decisions on the implementation of enhanced recovery technology in adult and child neurosurgery in terms of domestic neurosurgery.

Conclusion

Despite the lack of papers and the existing organizational challenges in the conditions of Russian healthcare, neurosur-

geons have a positive approach to the introduction of ERP into clinical practice. A group of Russian hospitals have already successfully introduced this guideline or its individual elements.

The implementation of technology is a logical outcome of the development of science and practice and reflects the development of approaches to the surgical treatment of patients worldwide. Therefore, it is important to further develop the technology of enhanced recovery after surgery and to perform randomized multicenter studies in the Russian Federation.

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The authors declare that they have no conflict of interest.
The study was approved by the local ethics committee of the institution.
All authors contributed significantly to the research and preparation of the article, read and approved the final version before publication.

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